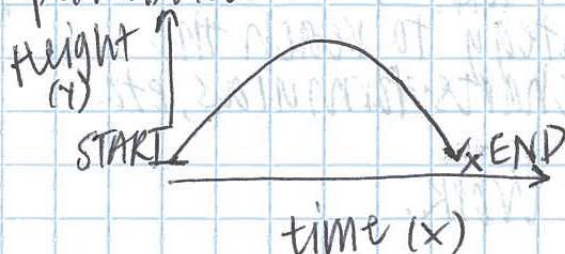


CRS	XEI 605 Solve quadratic equations
Objectives	1.11 Solve application problem using methods for solving quadratic equations

CW#7H - Real World Quadratics

Projectile Motion → any object that is thrown, shot, or dropped. It can move straight up and back down, which is the shape of a parabola:



ex) potato gun launcher
in Ms. Z's physics class

Projectile motion is the motion of an object subject to gravity. The vertical position of an object after t seconds on the earth is:

Height of the object
w/ respect to time

height time

$$h(t) = -16t^2 + v_0t + h_0$$

Force of gravity

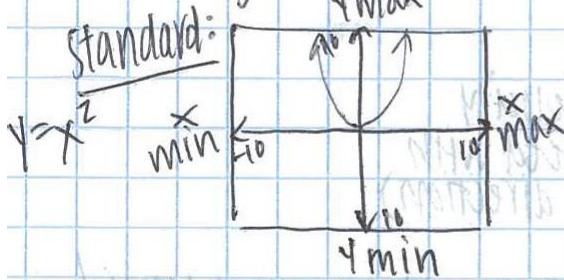
velocity
(speed with
a direction)

initial, or
starting height

FIRST:

Calc Functions for Quadratics: Input Function & Adjust Window

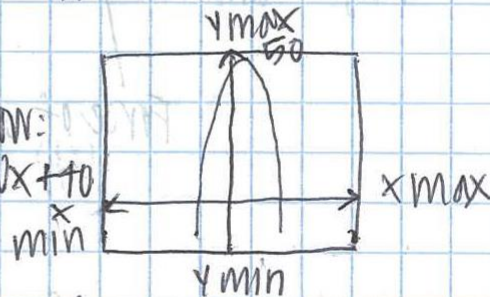
~~Find and Report~~ change the y-max to be approximately the initial height. ^{unless velocity is big} you may need to change the x max to be smaller



y max: 10
y min: -10
x max: 10
x min: -10

Possible adjusted window:

$$y = -16x^2 + 10x + 10$$



y max: 50
y min: -10
x max: 10
x min: -10

Any Height:

Zero:

Max/Min:

Intersect:

① **TRACE**

② input x-value

③ **ENTER**

① **2nd TRACE**

② #2 "zero" **ENTER**

③ left bound, enter
right bound, enter
enter 3rd time

① **2nd TRACE**

② #3 min | enter
#4 max | enter

③ left bound, enter
right bound, enter

① **2nd TRACE**

② #5 intersect

③ Enter on one line,
④ scroll over &

Name: _____ TP: _____

Example 1:

Ms. Ziegler throws a ball 5.5 feet from the ground at a velocity of 2 feet per second. The path of the ball can be represented by the equation

$h(t) = -16t^2 + 2t + 5.5$ where $h(t)$ represents the height of the ball and t represents the time the ball has been in motion. Create a sketch with all values.

- a) How long will it take for the ball to reach the ground?
- b) What is the maximum height of the ball?
- c) After how long does the ball reach its maximum height?

1) A movie stunt double jumps from the top of a building **50** feet above the ground onto a pad on the ground below. The stunt double jumps with an initial vertical velocity of **10** feet per second and the function $h(t) = -16t^2 + 10t + 50$ represents the height h (in feet) of the stunt double t seconds after she jumps. Create a sketch with all values.

- a) What height is the stunt double after 0.5 seconds?
- b) How many seconds does it take for the stunt double to reach the ground?

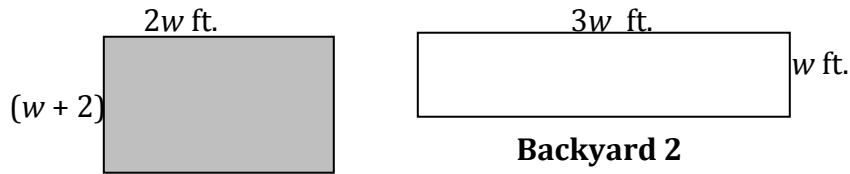
2) A football is punted from a height of 2.5 feet above the ground and with an initial vertical velocity of 45 feet per second. Create a sketch with all values.

- a. Write a vertical motion model to represent the situation.
- b. If the football is caught 5.5 feet above the ground ball, how long was the ball in the air?
- c. If the football is caught 2.5 feet above the ground, how long was the ball in the air?
- d. What is the maximum height of the football?

3) Two softball players are practicing catching fly balls. One player throws a ball to the other. She throws the ball upward from a height of 5.5 feet with an initial vertical velocity of 40 feet per second for her teammate to catch. Create a sketch with all values.

- a. Write an equation that models the height h (in feet) of the ball as a function of time t (in seconds) after it is thrown.
- b. If her teammate misses the ball and it lands on the ground, how long was the ball in the air?
- c. If her teammate catches the ball at a height of 4.5 feet, how long was the ball in the air?
- d. What is the maximum height of the softball?

3) Two fenced in backyards have the lengths and widths shown. The yards have the *same* area.



Backyard 1

a) Write the SIMPLIFIED equation that relates the areas of the two backyards: _____

b) Find the length, width, and perimeter of each yard:

Length of Yard 1: _____ / Width of Yard 1: _____ / Perimeter of Yard 1: _____

Length of Yard 2: _____ / Width of Yard 2: _____ / Perimeter of Yard 2: _____

5) Find a value of c that makes the equation

$3x^2 + 2x + c = 0$ have 1 solution, 2 solutions, and no real solution.

6) Solve the following by completing the square:

$$10k^2 + 20k - 37 = -7$$

7) The volume of a rectangular prism has the following dimensions:

Height: 2 Width: $(x - 1)$ Length: $(x + 4)$

a) Write a simplified polynomial that represents the volume of the box.

b) Determine what the dimensions of the height, width, and length are, if the volume of the box is 12 cubic inches.

Height: _____ / Width: _____ / Length: _____

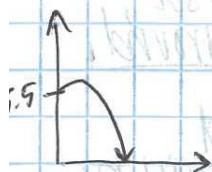
- 1) b: a.) How long for ball to reach ground
b.) Find max height of ball
c.) How long it takes to reach max height

height will be zero
↓

R: $h(t) = -16t^2 + 2t + 5.5$
height of ball, t = time

- a.) this is ~~zero function~~ x-intercept of
b.) vertex (max) of parab
c.) y-value at vertex

A: ~~Prework~~ Prework: input function & adjust window



- a.) use zero function on calc
b.) use max function on calc, look for y-value
c.) use max function on calc, look for x-value

S: a.) .45 It takes .45 seconds to reach ground

b.) 5.56 The max height is 5.56

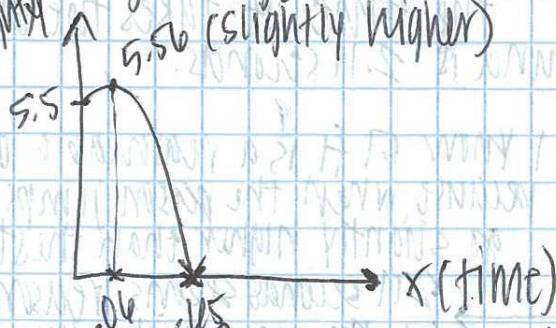
c.) It takes .06 seconds to reach max height

P. a.) 5.5 ft is not far from ground, so it will not take a lot of time for it to reach ground

b.) This is slightly higher than initial height which makes sense because of shape of parabola

c.) It takes .06 seconds, right at the beginning, to reach max height. This makes sense b/c the max (vertex) is close to the y-axis - which time is not very far yet

(initially) 5.56 (slightly higher)



It takes more time to reach max height

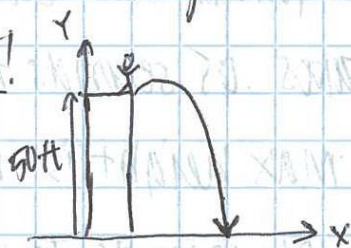
Focus. Determination. Pride.

Example 1):

- Goal:
- Find the height of the stunt double after 0.5 seconds.
 - Find out how long it will take for stunt double to reach ground.

Required: ① The quadratic equation: $h(t) = -16t^2 + 10t + 50$
↳ shape of graph will be parabola
② Graphing calculator to find height @ .5 sec. and time it takes for object to reach ground.
↓
when the object hits the ground the height will be zero. This will be one of the x-intercepts.

Analysis: PICTURE!



PRE-WORK:

Input function, adjust window (change max y-value to whatever the initial height is)

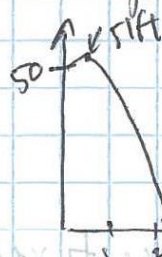
a.) TRACE, input .5 and record y-value

b.) 2nd, calc, #2 "zero", enter
left bound, enter
right bound, enter
enter 3rd time for zero

Solve:

- $y = 51$ The height at .5 seconds is 51 ft.
- $x = 2.11$ The time it takes the object to hit ground is 2.11 seconds.

Paraphrase:



I know 51 ft is a reasonable answer because when the person jumps they will go slightly higher than the starting position.
2.11 seconds seems reasonable b/c the jump will occur quickly. It's time after the 5 seconds.

Focus. Determination. Pride.

Example 2) G: a) write equation
 b) How long was ball in air when caught at 5.5 ft
 c) caught at 2.5 ft - how long in air?
 d) max height of the ball

R: a) 2.5 ft above ground = initial height
 45 ft/sec = velocity
 standard form: $-16t^2 + \square t + \square$

b) 5.5 ft intersects parabola
 \hookrightarrow horizontal line @ $y = 5.5$ ft

c) same - horizontal line at 2.5 ft

d) max height is y-value of vertex

A: a) use initial height & velocity to substitute into formula

b)] use input $y = 5.5$ & $y = 2.5$ & use
 c)] calc function of "intersect"

d) use max on calc - find y-value

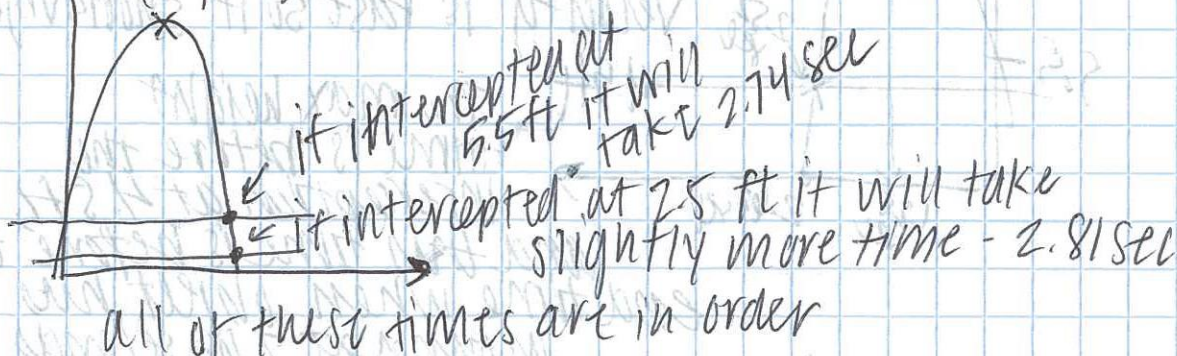
S: a) $y = -16t^2 + 45t + 2.5$

b) 2.74 seconds at 5.5 ft

c) 2.81 seconds at 2.5 ft

d) 34.1 is max height of ball (at 1.4 seconds)

P: $(1.4, 34.1) \rightarrow$ max height is 34 at 1.4 sec



Focus. Determination. Pride.

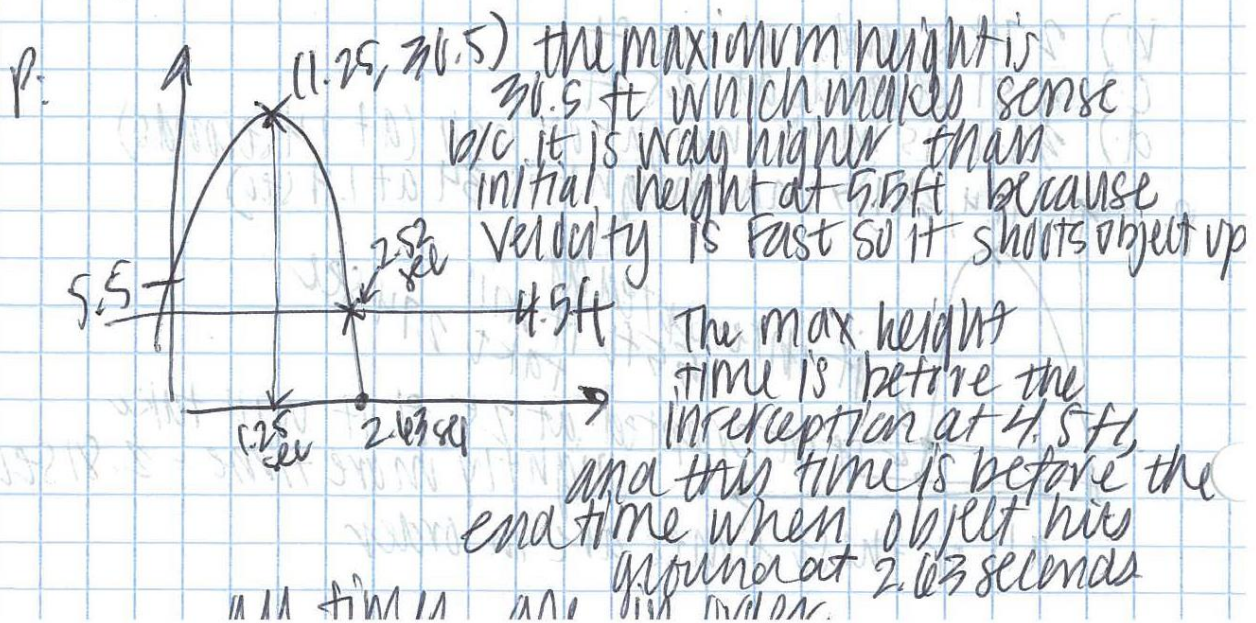
- #2) Q: a) write an equation
 b) how long will it take to reach ground
 c) how long in air if intercepted at 4.5
 d) maximum height of the ball

R: a) 5.5 ft = initial height & 40 ft/sec = velocity
 Standard form: $-16t^2 + 40t + 5.5$
 force of gravity velocity initial height

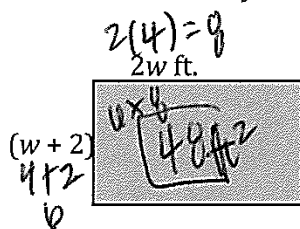
- b) when it reaches ground, $y=0$ & we have x-intercept
 c) if the path of parabola is interrupted or intercepted at 4.5, we can find intersection
 d) max height = y-value of vertex of parabola

A: a) use given info & substitute into formula.
 b) } use graphing calc to: find zero (time is x-value)
 c) } find intersection (time = x-val)
 d) } find max height (y-value)

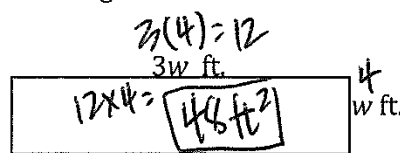
- S: a) $-16t^2 + 40t + 5.5$
 b) 2.63 seconds to reach the ground
 c) The ball will be intercepted at 2.52 at a height of 4.5
 d) The maximum height is 30.5 ft.



3) Two fenced in backyards have the lengths and widths shown. The yards have the *same* area.



Backyard 1



Backyard 2

$2W(W+2) = W(3W)$
 $2W^2 + 4W = 3W^2$
 $0 = W^2 - 4W$

a) Write the SIMPLIFIED equation that relates the areas of the two backyards: _____

b) Find the length, width, and perimeter of each yard: $0 = W(W-4)$ $W=0$
 $W=4$

Length of Yard 1: 8 ft / Width of Yard 1: 6 ft / Perimeter of Yard 1: $2(6) + 2(8) = 28 \text{ ft}$

Length of Yard 2: 12 ft / Width of Yard 2: 4 ft / Perimeter of Yard 2: $2(12) + 2(4) = 32 \text{ ft}$

5) Find a value of c that makes the equation

$3x^2 + 2x + c = 0$ have 1 solution, 2 solutions, and no real solution.

$\sqrt{b^2 - 4ac}$ (use discriminant)

$b^2 - 4ac = 0$ (1 solution)

$2^2 - 4(3)c = 0$

$4 - 12c = 0$

$-12c = -4$

$c = 4/12 = 1/3$

$4 - 12c > 0$ (will give 2 solutions)

$-12c > -4$

$c < 4/12$ $c < 1/3$

$4 - 12c < 0$ (will give no real solution)

$-12c < -4$

$c > 1/3$

6) Solve the following by completing the square:

$10k^2 + 20k - 37 = -7$

$10k^2 + 20k - 30 = 0$

$10(k^2 + 2k - 3) = 0$

$k^2 + 2k = 3$

$\frac{2}{2} = 1^2 = 1$

$k^2 + 2k + 1 = 4$

$(k+1)^2 = 4$

$k+1 = \pm 2$

$k = -1 \pm 2$

$k = 1, -3$

7) The volume of a rectangular prism has the following dimensions:

Height: 2

Width: $(x-1)$

Length: $(x+4)$

a) Write a simplified polynomial that represents the volume of the box.

$2(x-1)(x+4)$

$2(x^2 + 3x - 4) = 2x^2 + 6x - 8$

b) Determine what the dimensions of the height, width, and length are, if the volume of the box is 12 cubic inches.

$12 = 2x^2 + 6x - 8$

$= 2x^2 + 6x - 20$

$2(x^2 + 3x - 10) = 0$

$(x+5)(x-2) = 0$

Height: 2 / Width: $(2-1) = 1$ / Length: $(2+4) = 6$

$x = 2, -5$